

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference DSCX-1201-PC	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/US00/11944	International filing date (day/month/year) 01 MAY 2000	(Earliest) Priority Date (day/month/year) 08 JUNE 1999
Applicant DUNLOP MAXFLI SPORTS CORPORATION		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.
2. ☐ Certain claims were found unsearchable (See Box I).
3. ☐ Unity of invention is lacking (See Box II).
4. With regard to the **title**,
- ☐ the text is approved as submitted by the applicant.
- ☒ the text has been established by this Authority to read as follows:
Title not did not include the main feature (dimples).
THREE PIECE DISTANCE GOLF BALL WITH DIMPLES
5. With regard to the **abstract**,
- ☐ the text is approved as submitted by the applicant.
- ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. The figure of the **drawings** to be published with the abstract is Figure No. 2
- ☒ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.
- ☐ None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The technical features mentioned in the abstract do not include a reference sign between parentheses (PCT Rule 8.1(d)).

NEW ABSTRACT

A three piece golf ball (1) has a center compression in the range of about 40 PGA to 60 PGA, a center (5) weight in the range of about 27.5 grams to 28.5 grams, a core (6) compression in the range of about 60 PGA to 80 PGA, a core weight in the range of about 34.5 grams to 35.5 grams, a cover (2) hardness in the range of 63 to 69 Shore D, and an ionomer cover composition wherein the ionomer mixture comprises a blend of about 75 % by weight of a high resilience ionomer and about 25% by weight of a very low modulus ionomer. In addition, the present invention provides a golf ball (1) having a plurality of dimples (200,202,204), of about 402 in number, arranged on its outer surface, selected from two sets of dimples, the first set having a single radius cross section, and the second set having a dual radius cross section. The dimple configuration of the instant invention is based on the geometry of a rhombicosadodecahedron. A ball having such characteristics exhibits superior distance performance without compromising shot-making feel.

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A 63 B 37/12

US CL : 473/383

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 473/383, 378, 379, 380, 381, 382, 384,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,823,888 A (<i>MARUKO et al.</i>) 20 October 1998, See abstract.	1-14
Y	US 5,441,276 A (<i>LIM</i>) 15 August 1995, See figure 3a.	1-14
Y	US 5,064,199 A (<i>MORELL</i>) 12 November 1991, See abstract.	1-14
Y	US 5,092,604 A (<i>OKA</i>) 03 March 1992, see the entire document.	1-14
A	US 5,078,402 A (<i>OKA</i>) 07 January 1992.	
A	US 5,308,076 A (<i>SUN</i>) 03 May 1994.	

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

22 JUNE 2000

Date of mailing of the international search report

14 JUL 2000

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

JEANETTE CHAPMAN

Telephone No. (703) 308-1310

Sheila Venev
Paralegal Specialist
Technology Center 3700

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
ANTHONY M. LORUSSO
LORUSSO & LOUD
440 COMMERCIAL STREET
BOSTON, MA 02109

PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of Mailing
(day/month/year)

08 MAR 2001

Applicant's or agent's file reference

DSCK-1201-PC

IMPORTANT NOTIFICATION

International application No.

PCT/US00/11944

International filing date (day/month/year)

01 May 2000 (01.05.2000)

Priority date (day/month/year)

08 June 1999 (08.06.1999)

Applicant

DUNLOP MAXFLI SPORTS CORPORATION

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US

Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Mark Graham

Telephone No. 703-308-1355

Sheila Venev
Paralegal Specialist
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Name and mailing address of the IPEA/US

Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703)305-3230

Form PCT/IPEA/416 (July 1992)

Authorized officer

Mark Graham

Telephone No. 703-308-1355

Sheila Veney
Paralegal Specialist
Technology Center 3700

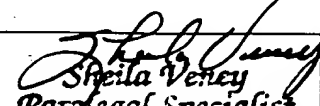
PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference DSKK-1201-PC	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/11944	International filing date (day/month/year) 01 May 2000 (01.05.2000)	Priority date (day/month/year) 08 June 1999 (08.06.1999)
International Patent Classification (IPC) or national classification and IPC IPC(7): A63B 37/12 and US Cl.: 473/383		
Applicant DUNLOP MAXFLI SPORTS CORPORATION		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>3</u> sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of <u>1</u> sheets.</p> <p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of report with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application 		
Date of submission of the demand 04 January 2001 (04.01.2001)	Date of completion of this report 15 February 2001 (15.02.2001)	
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Mark Graham Telephone No. 703-308-1355	


Sheila Vencey
Paralegal Specialist
Technology Center 2700

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International Application No.

PCT/US00/11944

I. Basis of the report

1. With regard to the elements of the international application:*

☒ the international application as originally filed.☒ the description:

pages 1-30 as originally filed

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

☒ the claims:

pages 31-38, as originally filed

pages NONE, as amended (together with any statement) under Article 19

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

☒ the drawings:

pages 1-7, as originally filed

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

☐ the sequence listing part of the description:

pages NONE, as originally filed

pages NONE, filed with the demand

pages NONE, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).☐ the language of publication of the international application (under Rule 48.3(b)).☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.☐ filed together with the international application in computer readable form.☐ furnished subsequently to this Authority in written form.☐ furnished subsequently to this Authority in computer readable form.☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.4. ☐ The amendments have resulted in the cancellation of:☐ the description, pages NONE☐ the claims, Nos. NONE☐ the drawings, sheets/fig NONE5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International Application No.

PCT/US00/11944

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement**1. STATEMENT**

Novelty (N)

Claims 1-25 YESClaims NONE NO

Inventive Step (IS)

Claims 1-25 YESClaims NONE NO

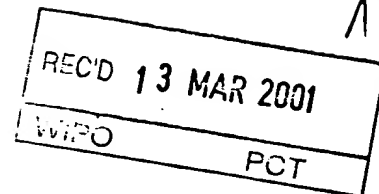
Industrial Applicability (IA)

Claims 1-25 YESClaims NONE NO**2. CITATIONS AND EXPLANATIONS (Rule 70.7)**

Claims 1-25 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest a three piece golf ball comprising a center and a thread windings layer, wherein the center has a compression in the range of about 60 PGA to 80 PGA and a weight in the range of about 27.5 to 28.5 grams, and wherein said thread windings layer has an unstressed thread dimension of about 0.020 inches to 0.028 inches by 1/16 of an inch, and has a 500% modulus between 220 and 280 psi, and a cover having a Shore D hardness in the range of about 63 Shore D to about 69 Shore D; and a plurality of dimples arranged on the outer surface, with a first pattern of dimples associated with each pentagon, a second pattern of dimples associated with each square and a third pattern of dimples associated with each triangle.

----- NEW CITATIONS -----

PCT



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference DSCK-1201-PC	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/11944	International filing date (day/month/year) 01 May 2000 (01.05.2000)	Priority date (day/month/year) 08 June 1999 (08.06.1999)
International Patent Classification (IPC) or national classification and IPC IPC(7): A63B 37/12 and US Cl.: 473/383		
Applicant DUNLOP MAXFLI SPORTS CORPORATION		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 04 January 2001 (04.01.2001)	Date of completion of this report 15 February 2001 (15.02.2001)
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Mark Graham Telephone No. 703-308-1355

Sheila Veney
Patent Specialist
Technology Center 3700

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/11944

I. Basis of the report

1. With regard to the elements of the international application:*



the international application as originally filed.



the description:

pages 1-30 as originally filedpages NONE, filed with the demandpages NONE, filed with the letter of _____.

the claims:

pages 31-38, as originally filedpages NONE, as amended (together with any statement) under Article 19pages NONE, filed with the demandpages NONE, filed with the letter of _____.

the drawings:

pages 1-7, as originally filedpages NONE, filed with the demandpages NONE, filed with the letter of _____.

the sequence listing part of the description:

pages NONE, as originally filedpages NONE, filed with the demandpages NONE, filed with the letter of _____.2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:



the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).



the language of publication of the international application (under Rule 48.3(b)).



the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

contained in the international application in printed form.



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furnished subsequently to this Authority in written form.



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The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:the description, pages NONEthe claims, Nos. NONEthe drawings, sheets/fig NONE5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/11944

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. STATEMENT**

Novelty (N)

Claims 1-25 YESClaims NONE NO

Inventive Step (IS)

Claims 1-25 YESClaims NONE NO

Industrial Applicability (IA)

Claims 1-25 YESClaims NONE NO**2. CITATIONS AND EXPLANATIONS (Rule 70.7)**

Claims 1-25 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest a three piece golf ball comprising a center and a thread windings layer, wherein the center has a compression in the range of about 60 PGA to 80 PGA and a weight in the range of about 27.5 to 28.5 grams, and wherein said thread windings layer has an unstressed thread dimension of about 0.020 inches to 0.028 inches by 1/16 of an inch, and has a 500% modulus between 220 and 280 psi, and a cover having a Shore D hardness in the range of about 63 Shore D to about 69 Shore D; and a plurality of dimples arranged on the outer surface, with a first pattern of dimples associated with each pentagon, a second pattern of dimples associated with each square and a third pattern of dimples associated with each triangle.

----- NEW CITATIONS -----

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
14 December 2000 (14.12.2000)

PCT

(10) International Publication Number
WO 00/74794 A1

(51) International Patent Classification⁷: **A63B 37/12**

(74) Agent: **LORUSSO, Anthony, M.**; Lorusso & Loud, 440 Commercial Street, Boston, MA 02109 (US).

(21) International Application Number: **PCT/US00/11944**

(22) International Filing Date: **1 May 2000 (01.05.2000)**

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:
60/138,078 **8 June 1999 (08.06.1999)** **US**

(71) Applicant (*for all designated States except US*): **DUNLOP MAXFLI SPORTS CORPORATION [US/US];**
100 Maxfli Drive, Westminster, SC 29693 (US).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **STANCZAK, Matthew, B. [US/US];** 10486 Long Creek Highway, Westminster, SC 29693 (US). **KUTTAPPA, Sanjay, M. [IN/US];** 109 Creekview Drive, Clemson, SC 29631 (US). **WALLACE, George, R. [US/US];** 103 Catabah Road, Clemson, SC 29631 (US). **LEMONS, Lane, D. [US/US];** 65 Raleigh Place, Jackson, TN 38305 (US).

(81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

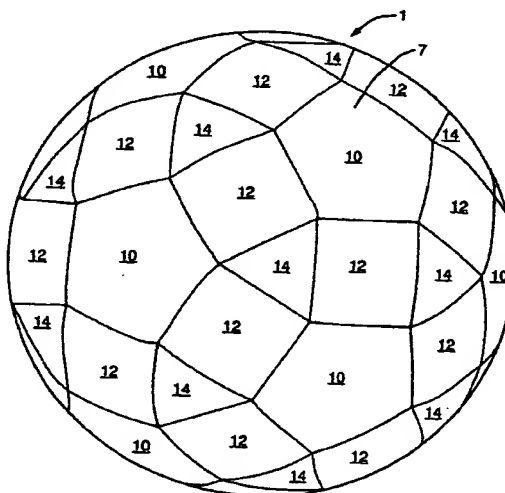
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: **THREE PIECE DISTANCE GOLF BALL WITH DIMPLES**



(57) Abstract: A three piece golf ball (1) has a center compression in the range of about 40 PGA to 60 PGA, a center (5) weight in the range of about 27.5 grams to 28.5 grams, a core (6) compression in the range of about 60 PGA to 80 PGA, a core weight in the range of about 34.5 grams to 35.5 grams, a cover (2) hardness in the range of 63 to 69 Shore D, and an ionomer cover composition wherein the ionomer mixture comprises a blend of about 75 % by weight of a high resilience ionomer and about 25 % by weight of a very low modulus ionomer. In addition, the present invention provides a golf ball (1) having a plurality of dimples (200, 202, 204), of about 402 in number, arranged on its outer surface, selected from two sets of dimples, the first set having a single radius cross section, and the second set having a dual radius cross section. The dimple configuration of the instant invention is based on the geometry of a rhombicosadodecahedron. A ball having such characteristics exhibits superior distance performance without compromising shot-making feel.

WO 00/74794 A1

THREE PIECE DISTANCE GOLF BALL WITH DIMPLES

CROSS-REFERENCE TO RELATED APPLIATIONS

A claim of benefit is made to U.S. Provisional Application Serial No. 60/138,078 filed June 8, 1999, the contents of which are incorporated herein by reference. This is a continuation-in-part application of the provisional application filed June 8, 1999, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The instant invention is directed to golf balls, and more particularly to a ball having the optimal cover hardness, cover composition, size of thread windings, center compression, center weight, center diameter, and dimple configuration to provide superior playability capabilities with respect to softness and spin without sacrificing superior distance capabilities.

DESCRIPTION OF THE PRIOR ART

It is well known in the golf industry that the distance a ball travels is one of the key features that distinguish one ball from the next. In the golf ball business, distance sells.

There are a number of physical properties that affect the performance of a golf ball. The core of the golf ball is the source of the ball's major elastic properties. In a three-piece golf ball, the core is comprised of the center and thread windings

layer of the golf ball. Among other things, the core affects the ball's "feel" and its initial velocity. The initial velocity is the velocity at which the golf ball travels immediately following impact. The initial velocity can be grouped with launch angle and spin to describe the ball's initial conditions, or the conditions exhibited by the ball immediately after impact. The initial conditions along with dimple pattern determine the ball's trajectory and ultimately its distance. The "feel" is the overall sensation transmitted to the golfer through the golf ball at impact. The overall construction of the ball influences the "feel" of a golf ball. Properties such as cover hardness, compression, and rebound can be used to gauge the response of a golfer to a ball's construction. But ultimately, the ball's "feel" can only be determined by the avid golfer. One property commonly tested by golfers to judge the "feel" of a ball is the sound made at impact between the ball and the club. This sound or "click" provides the golfer with a lasting impression of the ball's feel. Generally, lower cover hardness, compression, and rebound give the golfer an impression of a softer "feel" and a corresponding lower, softer click.

Until the late 1960's, most golf balls were constructed with a thread wound core and a cover of compounds based on natural balata and gutta percha or synthetic transpolyisoprene. These golf balls have been and are still known to provide good flight distance. Additionally, due to the relative softness of the balata cover, skilled golfers can impart various spins on the ball in order to control the ball's flight path (e.g., "fade" or "draw") and "bite" characteristics upon landing on a green.

"Fade" is a term used in golf to describe a particular golf ball flight path that is characterized by a curved or arched flight exhibited towards the latter portion of the flight path that veers off from the center line of the initial flight path to the opposite side from which the golfer stands. Upon contact with the ground, a ball hit with a "fade" will stop in a relatively short distance. This is a result of an open club face at impact imparting more spin and a higher trajectory than normal.

"Draw" is the term used in golf to describe a particular golf ball flight path that is characterized by a curved or arched flight exhibited towards the latter portion of the flight path that veers off from the center line of the initial flight path to the same side on which the golfer stands. Upon contact with the ground, a ball hit with a "draw", unlike that of a ball hit with a "fade", will roll for a considerable distance. This is a result of a closed club face at impact imparting less spin and a lower trajectory than normal.

"Check" or "bite" is the term used in golf to describe the effect of imparting a substantial amount of backspin to an approach shot into a green that causes the golf ball to stop abruptly upon contact with the green.

Another desirable feature of balata-based compounds is that they are readily adaptable to molding. These compounds therefore can be compression molded about a spherical core to produce golf balls.

Though possessing many desirable properties, there are substantial drawbacks to use of balata or transpolyisoprene-based compounds for golf ball covers. From a manufacturing standpoint, balata-type materials are expensive

and the manufacturing procedures used are time consuming and labor-intensive, thereby adding to the material expense. From a player's perspective, golf balls constructed with balata-based covers are very susceptible to being cut from mishits and being damaged from sharp grooves on a club face. As a result, they have a relatively short life span.

In response to these drawbacks to balata-based golf ball covers, the golf ball manufacturing industry has shifted to the use of synthetic thermoplastic materials, most notably ionomers sold by E. I. DuPont De Nemours & Company under the name SURLYN®. Surlyn is an ionomeric resin that is an ionic copolymer of an olefin having from about 2 to about 8 carbon atoms, such as ethylene, and a metal salt of an alpha, beta-ethylenically unsaturated mono- or dicarboxylic acid such as acrylic acid, methacrylic acid, or maleic acid. The pendent ionic groups in the ionomeric resins interact to form ion-rich aggregates contained in a non-polar polymer matrix. Metal ions, such as sodium, zinc, or lithium are used to neutralize some portions of the acid groups in the copolymer resulting in a thermoplastic elastomer exhibiting enhanced properties such as improved durability.

Thread wound balls with ionomer covers are less costly to manufacture than balls with balata covers. They are more durable and produce satisfactory flight distance. However, these materials are relatively hard compared to balata and thus lack the "feel" of a balata covered golf ball.

In an attempt to overcome the negative factors of the hard ionomer covers, DuPont introduced low modulus SURLYN® ionomers in the early 1980's. These

SURLYN® ionomers have a flexural modulus of from about 3000 to about 7000 PSI and hardness of from 25 to about 40 as measured on the Shore D scale - ASTM 2240. The low modulus ionomers are terpolymers, typically of ethylene, methacrylic acid and n or iso-butylacrylate, neutralized with sodium, zinc, magnesium or lithium cations. E.I. DuPont De Nemours & Company has disclosed that the low modulus ionomers can be blended with other grades of previously commercialized ionomers of high flexural modulus from about 30,000 to 55,000 PSI to produce balata-like properties. However, "soft" blends, typically 52 Shore D and lower (balata-like hardness), do not exhibit good physical properties and are prone to cut and shear damage.

The low modulus ionomers when used without high stiffness blends produce covers with very similar physical properties to those of balata, including poor cut and shear resistance. Worse, wound balls with these covers tend to go "out-of-round" quicker than wound balls with balata covers. Blending with hard SURLYN® ionomers was found to improve these properties.

Historically, in addition to manipulating the cover composition of a golf ball, golf ball manufacturers have also varied the size and winding conditions of the thread windings layer as well as the weight of the center in three-piece golf balls in an effort to design a golf ball with superior ball performance. Various efforts have been made to select the optimal winding pattern as well as the ideal thread dimension and winding tension.

For many years golf ball manufacturers have also investigated changing dimple configurations in an effort to design a ball with superior distance

capabilities. Dimples are the surface indentations or depressions on a golf ball. Specifically, ball manufacturers have looked to dimple configurations in an effort to design a ball with superior distance capabilities. Many efforts have been made to select the optimum number, size and shape of dimples as well as their disposition around the outer surface of a generally spherically shaped golf ball. However, a problem with the prior art dimple configurations is that they fail to take into account other features of the ball, such as core size, core compression and cover hardness, which also influence how far a ball will travel.

Dimples on golf balls are typically circular in elevation cross section, but a number of other designs are also utilized, including truncated cones, dimples within dimples, elliptical surfaces, hemispherical (or single radius) dimples, and dual radius dimples. For example, U.S. Patent No. 4,979,747 shows dimples having a frusto-conical elevation view cross section, and U.S. Pat. No. 5,005,838 shows dimples having complex shapes.

Different dimple shapes have different aerodynamic properties, and therefore, result in different performance characteristics. For example, a single radius dimple provides a more gradual entry of the airflow into the dimple, while a dual radius dimple provides a more abrupt entry of the airflow into the dimple. (A single radius dimple is one in which the elevation cross sectional shape of the dimple can be described by one radius, and dual radius dimple is one in which the elevation cross section is described by two radii.)

Generally, it has been found that the single radius dimple is the most optimal dimple shape for a high performance three-piece wound golf ball. By

contrast, the dual radius dimple is the most optimal shape design for two-piece distance balls for providing the desired golf ball flight trajectory. These dimple choices are based on the current view that the higher spinning performance balls require a more gradual entry of the airflow into the dimple to create the desired aerodynamic effects, whereas the low spinning distance ball requires a more abrupt entry of the airflow into the dimple to create the desired aerodynamic effect.

There are a number of hybrid type balls which do not fall squarely within either the three-piece performance category or the two-piece distance category. For example, two-piece performance balls and three-piece distance balls are hybrid balls which behave like performance balls for certain shots and like distance balls for other shots. As used herein the term "hybrid ball" is used to refer to a two piece performance ball, a three-piece distance ball, or any other ball which behaves like a performance ball for certain shots and like a distance ball for other shots.

It has been found, for instance, that a dimple pattern utilizing dual radius dimples allows for a lower more boring trajectory for a distance two-piece ball, whereas a pattern utilizing single radius dimples allows for a more consistent flight trajectory for high performance three-piece balls.

A need exists for a dimple pattern (and dimple shape) which takes into account the unique characteristics of the hybrid ball (i.e. the fact that it performs as a distance ball for certain shots, and as a performance ball for other shots) to provide optimum performance. The goal is to provide a ball that (i) provides slightly longer overall distance than a ball utilizing either all single radius dimples

or all dual radius dimples, and (ii) has a significantly lower trajectory, as exhibited by the lower rear trajectory value.

As is well known in the art, ball manufacturers are bound by regulations of the United States Golf Association (USGA) which control many characteristics of the ball, including the size and weight of the ball, the initial velocity of the ball when tested under specified conditions, the overall distance the ball travels when hit under specified test conditions, and the ball's aerodynamic symmetry. Under USGA regulations, the diameter of the ball cannot be less than 1.680 inches, the weight of the ball cannot be greater than 1.620 ounces avoirdupois, the initial velocity of the ball cannot be greater than 250 feet per second when tested under specified conditions (with a maximum tolerance of +2%), the driver distance cannot exceed 280 yards when tested under specified conditions (with a test tolerance of +6%), and the ball must perform the same aerodynamically regardless of orientation. It should be noted that while the USGA sets a limit for the distance a ball can travel under set test conditions, there is no upper limit on how far a player can hit a ball.

OBJECT OF THE INVENTION

Accordingly, it is an object of the instant invention to optimize the combination of center weight, center compression, size and winding conditions of the windings dimple, configuration, cover composition, and cover hardness to provide a three-piece golf ball, which travels great distances, and at the same time complies with USGA regulations.

It is another object of the instant invention to provide a three-piece golf ball that has a soft "feel" in combination with superior distance capabilities.

It is yet another object of the instant invention to provide a three-piece golf ball having a synthetic cover material that achieves the sound, feel, and playability and flight performance qualities of balata covered golf balls.

It is still a further object of the instant invention is to provide a three-piece golf ball having superior distance, trajectory and flight stability.

Another object of the instant invention is to provide a three-piece golf ball having a surface divided into a plurality of polygonal configurations or shapes for the location of dimples for enhancing the aerodynamic properties of the golf ball.

It is yet another object of the present invention to provide a golf ball dimple pattern that optimizes the performance characteristics of the instant invention.

It is still another object of the present invention to provide a hybrid golf ball that provides a slightly longer overall distance and a lower trajectory than the prior art hybrid balls.

It is still a further object of the invention to provide a golf ball having a dimple pattern that incorporates dimples of different sizes to maximize the aerodynamic qualities for each such dimple shape.

It is yet another object of the present invention to provide a golf ball having superior distance, trajectory and flight stability.

SUMMARY OF THE INVENTION

The invention achieves the above-described objectives by providing a three-piece golf ball having a solid rubber center, a thread windings layer whose threads are a large gauge and which is wound in an "open" basket weave pattern, a synthetic ionomer resin cover, and a "rhombicosadodecahedron" dimple pattern. The ball of the instant invention has a core compression in the range of 60 PGA to 80 PGA, a center weight in the range of 27.50-28.50 grams, a center size of between 1.34 to 1.37 inches, an unstressed (not wound) thread dimension of about $0.024 \pm .004$ inches height by $1/16^{\text{th}}$ of an inch width, a cover hardness in the range of about 63 Shore D to about 69 Shore D, and a dimple pattern based on the geometry of a rhombicosadodecahedron. This combination has been found to produce a ball with superior distance capabilities and superior playability capabilities with respect to softness and spin. The use of these properties in the golf ball of the instant invention is based on the recognition that it is the combination of the center size and weight, the size, modulus, and tension of the thread windings, cover hardness, dimple configuration, dimple size and dimple shape that will produce a ball that will travel the greatest distance without compromising shot-making feel.

The golf ball of the present invention has a conventional, solid rubber center or rubber sphere. In a preferred embodiment of the invention, the center has a weight that is slightly heavier than in golf balls manufactured previously. The use of a heavier center is necessary in order to attain a golf ball with sufficient weight to maximize distance and still meet USGA standards. In

particular, as mentioned previously, the instant golf ball has a synthetic ionomer resin cover. This cover has a relatively low specific gravity and as a consequence, a lower weight. Therefore, to manufacture a ball of sufficient weight, a heavier center is used.

The thread of the golf ball of the invention is cut from a sheet that is about 0.020 inches to 0.028 inches in thickness or height. A typical thickness is 0.024 inches, which corresponds to a "gauge" of 24. The width of the thread cut for the instant invention is about 1/16th inch.

It has now been discovered that the combination of a relatively heavy center with a large gauge thread, of about 0.024 ± 0.004 inches, and having relatively low Swartz modulus, and width of about 1/16th of an inch (0.063 ± 0.004 inch), wound to promote an "open" winding pattern under a tension in the range of 925 to 1025 grams of tension produces a ball with improvements in player characteristics. Specifically, the heavy center surrounded by a thread windings layer comprised of a large gauge thread wound to an "open" winding pattern results in a three piece golf ball that spins less than known inventions when it is hit by a driver, while spinning more when it is hit by a pitching wedge. Lower spin off the driver is preferable as it increases the total distance attained from a golf ball.

The use of the relatively large gauge, wide thread, wound to an "open" winding pattern, allows the ionomer resin into which the thread-wound solid rubber center is placed, to penetrate or seep into the thread windings layer to a

greater extent than in the prior art balls. The result is a softer-feeling ball than would be attained otherwise.

The cover material can be constructed from any relatively stiff material, for example, synthetic thermoplastic materials. Most notably these synthetic thermoplastic materials are ionomeric resins. Ionomeric resins are polymers containing interchain ionic bonding. As is well known in the chemical arts, ionomeric resins are generally ionic copolymers of an olefin having from about two to about eight carbon atoms, such as ethylene and a metal salt of an unsaturated carboxylic acid, such as acrylic acid, methacrylic acid, or maleic acid. The pendent ionic groups in the ionomeric resins interact to form ion-rich aggregates contained in a non-polar polymer matrix. Metal ions, such as sodium, zinc or magnesium are used to neutralize some portion of the acidic groups in the copolymer. This results in a thermoplastic elastomer, which exhibits enhanced flight characteristics and durability when compared to golf balls constructed with balata covers. However, the advantages gained by enhanced durability have been offset by the decreased playability properties.

The ionomers used in the cover composition are sold by E.I. Dupont De Nemours & Company under the name SURLYN®. In an attempt to overcome the negative factors of the hard ionomer covers, DuPont introduced low modulus SURLYN® ionomers in the early 1980's. These SURLYN® ionomers have a flexural modulus of from about 3000 to about 7000 PSI and hardness of from 25 to about 40 as measured on the Shore D scale - ASTM 2240. The low modulus ionomers are terpolymers, typically of ethylene, methacrylic acid and n or iso-

butylacrylate, neutralized with sodium, zinc, magnesium or lithium cations. E.I. DuPont De Nemours & Company has disclosed that the low modulus ionomers can be blended with other grades of previously commercialized ionomers of high flexural modulus from about 30,000 to 55,000 PSI to produce balata-like properties. However, soft blends, typically 52 Shore D and lower (balata-like hardness), are still prone to cut and shear damage.

The low modulus ionomers when used without high flexural modulus blends produce covers with very similar physical properties to those of balata, including poor cut and shear resistance. Worse, wound balls with these covers tend to go "out-of-round" quicker than wound balls with balata covers. Blending with hard SURLYN® ionomers was found to improve these properties.

It has now been discovered that a blend of a high resilience ionomer with an associated high acid level with a soft ionomers containing low acid level results in a golf ball cover with improved playability characteristics. For the purposes of the SURLYN® ionomer resin grade designations, a high acid level is approximately 19% by weight, and a low acid level is approximately 12% by weight.

As mentioned previously, in addition to manipulating the center, thread windings layer, and cover parameters in a golf ball, superior aerodynamic properties are also attributed to the dimple configuration on a golf ball. In the instant invention, the dimples are arranged on the surface of the golf ball based on the geometry of a rhombicosadodecahedron.

The golf ball of the instant invention has a dimple pattern that incorporates dimples of different shapes to maximize the aerodynamic properties of the ball.

The dimple shapes may be selected from any known dimple shapes, including but not limited to truncated cones, squares, triangles, dimples within dimples, elliptical surfaces, single radius dimples, and dual radius dimples. The invention allows for the combination of any of the possible dimple shapes into a single dimple pattern to allow a more optimized golf ball flight trajectory.

The golf ball of the preferred embodiment is a hybrid ball in which the dimple pattern on the surface of the ball includes both single radius and dual radius dimples in order to achieve the most optimal flight performance. This hybrid ball is allowed to best utilize the aspects of single radius dimples for shots where it behaves more like a performance three-piece ball, and the aspects of dual radius dimples for shots where it behaves like a distance ball, while maintaining good flight performance and control with a combination of both. The ball provides slightly longer overall distance, and a significantly lower trajectory than the prior art hybrid balls. This is a much desired property for this type of ball.

The dimples are arranged by dividing the outer spherical surface of a golf ball into a plurality of polygonal configurations, including pentagons, squares and triangles for locating a plurality of dimples on the outer surface of the golf ball. The polygonal configurations of this invention are preferably a combination of regular pentagons, squares and triangles to cover the outer surface. This first plurality of polygonal configurations is generally referred to herein as a "rhombicosadodecahedron". The rhombicosadodecahedron is further characterized by a uniform pattern of pentagons formed over the outer surface each bounded by triangles and squares.

The preferred embodiment utilizes a pattern of 402 dimples arranged in the construction of the rhombicosadodecahedron. A pair of first polygonal configurations, each located on opposite sides of the outer surface, include one of the two poles symmetrically arranged within its boundaries. The outer surface has a plurality of dimples of different sizes. In one embodiment, the dimples are of first, second and third sizes and are generally located to have a first pattern associated with the pentagons, a second pattern associated with the squares, and a third pattern associated with the triangles.

In another embodiment of the invention, the outer surface of the golf ball includes a plurality of parting lines along great circle paths of the ball for further dividing the first plurality of polygonal configurations into a second plurality of polygonal configurations, each of which are smaller than the polygonal configurations of the first polygonal configurations. The dimples are arranged over the outer surface by being associated with both the first and the second plurality of polygonal configurations.

The combination of the aforementioned center, thread windings layer, cover and dimple specifications produces a golf ball that possesses noticeable improvements in playability (i.e. softness in feel) without sacrificing the ball's durability (i.e. impact resistance etc.). This combination also contributes directly to the distance that a ball will travel when struck. These and other objects of the instant invention will be apparent from a reading of the following detailed description of the instant invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross sectional view of a three-piece golf ball made in accordance with one embodiment of the invention.

Figure 2 is an elevation view of the outer surface of a golf ball being divided into a plurality of polygonal configurations according to the invention;

Figure 3 is an elevation view of the golf ball of this invention showing the relative locations of pentagons, squares and triangles formed on the outer surface with a pole at the center of a pentagon;

Figure 4 is an equatorial view of the ball of the preferred embodiment of the present invention, and includes polygons projected thereon.

Figure 5 is a polar view of the ball shown in Fig. 4 and includes polygons projected thereon.

Figure 6 is a cross sectional view of a single radius dimple;

Figure 7 is a cross sectional view of a dual radius dimple; and

Figure 8 is a cross sectional view cut through one of the dimples on the outer surface of the ball.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in Fig. 1, the golf ball is comprised of a solid spherical rubber center 6, a thread windings layer 4, and a cover 2 to make a three-piece golf ball. The solid rubber center 6 together with the thread windings layer 4 comprise the core 5 of the golf ball. In the preferred embodiment, the golf ball center 6 has a diameter of about between 1.34 inches to 1.37 inches, preferably 1.354 inches, a

PGA compression in the range of about 40 to about 60, and weighs about 27.5 grams to 28.5 grams, preferably about 28.0 grams. When combined, the solid rubber center 6 and the thread windings layer 4 form the core 5 measuring approximately 1.565 ± 0.010 inches in diameter, and having a weight of about 35.0 ± 0.5 grams.

The thread windings layer 4 is comprised of thread cut from sheets of polyisoprene rubber and/or natural rubber and their blends thereof. The unstressed (unwound) thread dimensions are preferably 0.024 inches thickness or height and a thread width of about $1/16^{\text{th}}$ inch. The thread windings are wound in an "open" pattern due to the relatively large size of the thread. The thread windings are wound under a tension from about 900 grams to 1100 grams, to a thread winding thickness of between 0.092 inches to 0.118 inches, preferably about 0.105 inches.

The windings layer of the instant invention has a lower density than is found in other ionomer resin golf balls. Specifically in the preferred embodiment, the unstressed dimensions for thread used in the windings of the golf ball are about 0.020 inches to about 0.028 inches in height, preferably about 0.024 inches, with a width of about 0.059 to about 0.067 inches and preferably $1/16^{\text{th}}$ of an inch. In contrast to a gauge of 24, corresponding to 0.024 inches, the gauge of threads used in other windings is smaller, 17, or 0.017 inches. Advantageously, the use of a large gauge (about 24) thread in the winding layer produces a golf ball that spins less off the driver when compared to a golf ball produced with a smaller gauge (17) thread. This decrease in spin when the instant ball is hit by a

driver occurs as a consequence of the novel construction of a heavy center combined with a thread winding layer that has threads with a lesser density. The larger gauge used for the threads in the thread windings layer results in a golf ball that has a more "open" pattern for the windings. Advantageously, this second design feature for the windings with regard to the "open" winding pattern allows more reactive ionomer resin to penetrate into the core of the golf ball during its manufacture.

The winding conditions for the thread windings layer also contribute significantly to the novel character of the instant ball. In particular, the tension under which the thread is wound affects the PGA compression of the resultant golf ball. In the preferred embodiment, the golf ball is wound at a tension in the range of about 900 grams of tension to about 1100 grams of tension, preferably, 1000 grams of tension. This winding tension produces a golf ball with a core compression in the range of 60 PGA to 80 PGA, preferably 70 PGA. A core compression in this range resulting from the unique character of the thread windings layer, coupled with the heavy center produces a golf ball that is able to maintain great distance and carry while simultaneously having a flight path with a lower trajectory. Advantageously, a lower trajectory in the flight path causes the golf ball to land at an acute angle to the ground. In turn, this acute landing promotes more roll, and thus the golf ball will travel a greater distance when it hits the ground.

In the preferred embodiment, the cover has a thickness of about 0.078 ± 0.015 inches to provide a total diameter of center 6, thread windings layer 4 and

cover 2 of 1.680 inches, the commercial ball diameter standard specified by the United States Golf Association.

As discussed previously, the cover material is comprised of ionomer resins available from E.I. du Pont de Nemours & Co. under the name SURLYN®. In the preferred embodiment, the ionomers are 75% by weight of SURLYN® 8140, and 25% by weight of SURLYN® 9320W. The hardness of the cover 2 is about 66 ± 3 Shore D.

Under the Dupont SURLYN® resin classification system, the 8140 SURLYN® ionomer is classified as a high resilience ionomer. The 8140 SURLYN® ionomer is defined as a copolymer including approximately 81% of an olefin, most commonly ethylene, and about 19% of an alpha, beta ethylenically unsaturated carboxylic acid, such as acrylic or methacrylic acid. Moreover, this ionomer uses the Sodium metal ion to neutralize the acid groups, and, as stated, its acid level is about 19% by weight, which is considered a high acid level to those skilled in the art. In turn, this high acid level is associated with a resin characterized by a high stiffness level. Moreover, the 8140 SURLYN® grade has no terpolymer. Finally, the 8140 SURLYN® resin has a melt index of about 2.6.

The 9320W SURLYN® resin is classified as a very low modulus ionomer which has a low acid level of about 12 % by weight, which in turn produces a resin characterized by a low stiffness level. The 9320W SURLYN® ionomer is comprised of 67-70% by weight of ethylene, 20-21% by weight of n-butyl acrylate, and 12% by weight of methacrylic acid. In addition, the 9320W SURLYN® resin uses the Zinc

ion to neutralize the acid groups, and it is a terpolymer. Finally, the 9320W SURLYN[®] resin has a melt index of about 0.7.

In addition to the SURLYN[®] resins, the cover composition contains color concentrate for coloring the golf ball in an amount well known to those skilled in the art.

Turning now to the dimple technology employed in the instant invention, as stated previously, the preferred geometry is a rhombicosadodecahedron. The dimple configuration will normally be applied to the ball during the molding of the cover around the core by using appropriately shaped compression molding cavities common to those skilled in the art. The molded golf ball having the desired dimple configuration may be then painted. Alternately, painting may be unnecessary for one-piece golf balls using a cover having a suitable compounding of the composition used.

Accordingly, the scope of this invention provides a golf ball mold whose molding surface contains a uniform pattern to give the golf ball a dimple configuration superior to those of the prior art. The invention is preferably described in terms of the golf ball that results from the mold, but could be described within the scope of this invention in terms of the mold structure that produces a golf ball.

To assist in locating the dimples on the golf ball, the golf ball 1 of this invention has its outer spherical surface partitioned by the projection of a plurality of polygonal configurations onto the outer surface. That is, the formation or division that results from a particular arrangement of different polygons on the

outer surface of a golf ball is referred to herein as a "plurality of polygonal configurations." A view of one side of a golf ball 1 showing a preferred division of the golf ball's outer surface 7 is illustrated in Fig. 2.

In the preferred embodiment, a polygonal configuration known as a rhombicosadodecahedron is projected onto the surface of a sphere. A rhombicosadodecahedron is a type of polyhedron which contains thirty (30) squares, twenty (20) polyhedra of one type, and twelve (12) polyhedra of another type. The term "rhombicosadodecahedron" is derived from "dodecahedron," meaning a twelve (12) sided polyhedron; "icosahedron," meaning a twenty (20) sided polyhedron, and "rhombus" meaning a four (4) sided polyhedron.

The rhombicosadodecahedron of the preferred embodiment is comprised of thirty (30) squares 12, twelve (12) pentagons 10, and twenty (20) triangles 14. It has a uniform pattern of pentagons with each pentagon bounded by triangles and squares. The uniform pattern is achieved when each regular pentagon 10 has only regular squares 12 adjacent to its five boundary lines, and when a regular triangle 14 extends from each of the five vertices of the pentagon. Five (5) squares 12 and five (5) triangles 14 form a set of polygons around each pentagon 10. Two boundary lines of each square 12 are common with two pentagon boundary lines, and each triangle 14 has its vertices common with three pentagon vertices.

The outer surface of the ball is further defined by a pair of poles and an equatorial great circle path around the surface. A great circle path is defined by the intersection between the spherical surface and a plane that passes through the center of the sphere. An infinite number of great circle paths may be drawn on any

sphere. The equatorial great circle path in the preferred embodiment corresponds to a mold parting line that separates the golf ball into two hemispheres. The mold parting line is located from the poles in substantially the same manner as the equator of the Earth is located from the North Pole and the South Pole.

Referring to Fig. 3, the poles 70 are located at the center of a pentagon 10 on the top and bottom sides of the ball, as illustrated in this view of one such side. The mold parting line 30 is at the outer edge of the circle in this planar view of the golf ball.

Dimples are placed on the outer surface of the golf ball based on segments of the plurality of polygonal configurations described above. In the preferred embodiment, three (3) dimples are associated with each triangle 14, five (5) dimples are associated with each square 12, and sixteen (16) dimples are associated with each pentagon 10. The term "associated" as used herein in relation to the dimples and the polyhedra means that the polyhedra are used as a guide for placing the dimples.

The dimple configuration of the preferred embodiment is shown in Figs. 4-5. It is based on the projection of the rhombicosadodecahedron shown in Fig. 2. The ball has a total of 402 dimples. The plurality of dimples on the surface of the ball are selected from three sets of dimples, with each set having different sized dimples. Dimples 200 are in the first set, dimples 202 are in the second set, and dimples 204 are in the third set. Dimples are selected from all three sets to form a first pattern associated with the pentagon 10. All sides 206 of each pentagon 10 are intersected by two dimples 202 from the first set of dimples and one dimple 202

from the second set of dimples. All pentagons 10 have the same general first pattern arrangement of dimples.

Dimples 200, 202 and 204 (from all three sets of dimples) are also used to form a second pattern associated with the squares 12. All sides 208 of each square 12 are intersected by dimples 202 from the second set of dimples, and all squares 12 have the same general second pattern arrangement of dimples.

Dimples 202 from the second set of dimples form a third pattern associated with the triangles 14. All sides 210 of each triangle 14 are intersected by a dimple 202 from this second set of dimples. All triangles 14 have this same general third pattern arrangement of dimples. The mold parting line 30 is the only dimple free great circle path on this ball.

The ball of the preferred embodiment utilizes two different types of dimples having two different cross-sections, single radius dimples 200 and 204 and dual radius dimples 202. In the single radius dimple (Fig. 6), a single radius (referred to as a major radius, or Radius 1) describes the shape of the bottom of the dimple. In other words, the major radius governs the shape of the dimple toward the bottom of the dimple. In a dual radius dimple (Fig. 7), on the other hand, two radii are used to describe the shape of the dimple. The major radius describes the bottom of the dimple, and a minor radius (Radius 2) describes the shape of the dimple about its circumference.

Dimple size is measured by a diameter and depth generally according to the teachings of U.S. Patent No. 4,936,587 (the '587 patent), which is included herein by reference thereto. An exception to the teaching of the '587 patent is the

measurement of the depth, which is discussed below. A cross-sectional view through a typical single radius dimple 6 is illustrated in Fig. 8. The diameter Dd used herein is defined as the distance from edge E to edge F of the dimple. Edges are constructed in this cross-sectional view of the dimple by having a periphery 50 and a continuation thereof 51 of the dimple 6. The periphery and its continuation are substantially a smooth surface of a sphere. An arc 52 is inset about 0.003 inches below curve 50-51-50 and intersects the dimple at point E' and F'. Tangents 53 and 53' are tangent to the dimple 6 at points E' and F' respectively and intersect periphery continuation 51 at edges E and F respectively. The exception to the teaching of '587 noted above is that the depth d is defined herein to be the distance from the chord 55 between edges E and F of the dimple 6 to the deepest part of the dimple cross sectional surface 6 (a), rather than a continuation of the periphery 51 of an outer surface 50 of the golf ball.

The dimple dimensions for the preferred embodiment are set forth below:

<u>Dimple (number)</u>	<u>Diameter (in)</u>	<u>Type</u>	<u>Radius1(in)</u>	<u>Radius</u>
<u>2(in)</u>				
200 (60)	.156	Single	.4148	NA
202(150)	.145	Dual	.7874	.1181
204(192)	.140	Single	.3535	NA

It is understood that the following dimple size ranges are within the scope of this invention: dimples 200 from the first set may have a diameter in the range of 0.150 inches to 0.160 inches; dimples 202 from the second set may have a diameter in the range of 0.140 inches to 0.150 inches; dimples 204 from the third set may have a diameter in the range of 0.135 inches to 0.145 inches; all dimples, 200, 202 and 204

may have a depth in the range of 0.0056 inches to 0.0078 inches; the major radius may be in the range of 0.34 inches to 0.80 inches; and the minor radius (for dimple 202) may be in the range of 0.10 inches to 0.12 inches.

The following test data illustrates the improved performance of the dimple pattern of the present invention. Each of the balls identified below is a hybrid ball.

<u>BALL #DIMPLES</u>	<u>PATTERN TYPE</u>	<u>CARRY(YDS)</u>	<u>TOTAL(YDS)</u>	<u>REAR TRAJ.</u>
BB344	402 all single rad.	247.8	268.0	8.4
BB351	402 all dual rad.	246.3	268.2	8.2
BB370	402 combination	246.6	270.0	8.2
Control	392 all single rad.	245.6	267.5	8.3

As shown above, the ball of the present invention, which utilizes both single radius and dual radius dimples, provides slightly longer overall distance than a ball utilizing either all single radius dimples or all dual radius dimples, and it has a significantly lower trajectory, as exhibited by the lower rear trajectory value. This is a much-desired property for the hybrid ball.

Turning now to the method of manufacturing the instant golf ball, it is to be appreciated that a preferred embodiment of the golf ball is produced according to standard methods well known to those skilled in the art. In particular, the solid rubber center 6 is manufactured using conventional compression molding processes. The components are mixed together and extruded to form preforms, which are then placed in cavities in the mold and are compression molded under pressure and cured or vulcanized to form centers. The same mix may also be injection molded. Curing is carried out in the mold at temperatures of 280°F-380°F

for five to twenty minutes depending on the compound. Once fully cured, the center 6 is removed from the mold cavities and prepared for application of the thread windings layer.

In the preferred embodiment, the golf ball center 6 is made of a solid rubber composition comprising a polybutadiene rubber center of a composition typical to the industry. Specifically, the rubber may be 90-100 PHR polybutadiene, 0-10 PHR polyisoprene, 15-30 PHR zinc diacrylate, 3-10 PHR zinc oxide, 45-65 PHR fillers, activators, process aids and antioxidants, and 0.5-5 PHR peroxide initiator. In the preferred embodiment, the diameter of the solid rubber center 6 is about 1.355 ± 0.015 inches. The center 6 weighs about 28.0 ± 0.5 grams, and has a compression of about 50 ± 10 PGA.

As is well known in the art, the type and amount of crosslinking agents used to make the center 6 will have the greatest influence on the center compression achieved. To prepare the center 6 according to the preferred embodiment, it has been found that a center composed primarily of high-cis polybutadiene in combination with cross-linking agents, activators, initiators and fillers (active and inactive), can be used to achieve a golf ball center having the desired compression characteristics. As used herein, high-cis means a cis isomer content of greater than 93%. It is to be understood that the center formula set forth herein is but one formula that can be used to make a center having the desired center compression.

Once formed, the solid rubber center 6 is then wound with thread windings in an open pattern with a thread tension from about 900 grams to 1100 grams,

wherein the thread windings have an unstressed thread dimension of about $1/16^{\text{th}}$ of an inch width by about 0.020 inches to 0.028 inches height, and a 500% modulus between 220 to 280 p.s.i.-. The resultant core, 5 is then subjected to a conventional molding process according to standard methods, whereby the SURLYN® cover 2 is compression molded around the wound core 5 in a manner well known to those skilled in the art. In the preferred embodiment, compression molding consists of injecting an ionomer mixture constituting the blended Surlyn® components into 'half shells'. The core is placed between two 'half shells' and then placed into a golf ball mold comprising a first mold half and a second mold half, whereby each of the mold halves are larger in dimension than the finished cover. It should be noted that the inner surfaces of the golf ball mold are constructed with dimple-shaped projections, which form the dimples in the cover in a configuration according to the invention as described above.

After molding, the golf balls produced may undergo further processing steps such as pressure blasting, vibratory finishing, stamping of the logo, application of a primer, and finally, application of a top coat.

The following examples are provided to illustrate and further explain the beneficial effects of the ball described above. These examples are set forth for the purposes of illustrating the advantages obtained with the combination of the center compression, center weight, thread size, thread winding tension, core compression, core size, cover composition, cover hardness, cover thickness, dimple configuration, and dimple number that will produce a ball that will travel the greatest distance without compromising shot-making feel.

EXAMPLE 1

Two flight tests were conducted comparing the flight characteristics of the instant invention, i.e., the Three-Piece Distance Golf Ball, known under the trade name as the Maxfli Tour Patriot, with two other golf balls against which it competes in the marketplace. The golf balls were hit with a driver and various parameters were measured and are summarized below.

Example 1

Ball	Test #2095	Test # 2217
	Driver	Driver
	Carry (yards)	Carry (yards)
	Total (yards)	Total (yards)
	Spin (rpm)	Spin (rpm)
<hr/>		
Maxfli Tour Patriot	240.7	246.0
	272.1	263.8
	2622	2563
Titleist Tour Distance	232.9	237.9
	266.5	255.7
	2669	2609
Titleist DT Wound		244.2
		261.4
		2814

Advantageously, as is clearly demonstrated by the test results, the use of a golf ball configured according to the aforementioned center, core, cover and dimple parameters results in a golf ball, the Three-Piece Distance Golf Ball, which has longer flight characteristics than balls manufactured by competitors.

As was discussed previously, the improvements in ball performance of the invention are due to the combination of changes in the center weight, the size and winding conditions of the thread, the cover material, and the dimple pattern of the golf ball. In the invention, the novel manipulation of these parameters creates a ball that spins less and travels further when hit by a driver, while being able to spin more and have superior shot-making feel when hit by a pitching wedge. These two desirable playability characteristics are possible in the instant golf ball due to the unique construction of this ball.

As is known in the art, when a golf ball is hit by a driver, there is great impact force. The whole ball is deformed under this impact force. Consequently, the entire construction of the ball accounts for its initial launch conditions and ensuing flight performance. In the instant invention, the critical difference contributing to the superior distance capability is the center weight, the center compression, the thread windings layer, the core compression, and the cover composition in conjunction with the dimple configuration.

While the present invention has been described in connection with preferred embodiments thereof, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the true spirit and scope of the present invention. It is to be understood that the instant

invention is by no means limited to the particular embodiments herein disclosed, but also comprises any modifications or equivalents within the scope of the claims. For example, it is understood that the invention is not limited to a dimple pattern defined by the rhombicosadodecahedron.

Accordingly, it is intended by the appended claims to cover all such changes and modifications as come within the true spirit and scope of the invention. Having thus described our invention, what we claim as new and desire to secure by United States Letters Patent is:

1. A three-piece golf ball comprising:

a core comprising a center and a thread windings layer, wherein said center has a compression in the range of about 60 PGA to 80 PGA and a weight in the range of about 27.5 grams to 28.5 grams, and wherein said thread windings layer has an unstressed thread dimension of about 0.020inches to 0.028inches by 1/16 of an inch, and has a 500% modulus between 220 to 280 p.s.i.;

a cover having a Shore D hardness in the range of about 63 Shore D to about 69 Shore D; and

a plurality of dimples arranged on the outer surface, with a first pattern of dimples associated with each pentagon, a second pattern of dimples associated with each square, and a third pattern of dimples associated with each triangle.

2. The golf ball of claim 1 wherein the center has a diameter in the range of about 1.340 inches to about 1.370 inches.

3. The golf ball of claim 1 wherein the core has a weight in the range of about 34.5 grams to about 35.5 grams.

4. The golf ball of claim 1 wherein the core has a compression in the range of about 60 PGA to about 80 PGA.

5. The golf ball of claim 1 wherein the core has a diameter in the range of about 1.555 inches to about 1.575 inches.

6. The golf ball of claim 1 wherein the cover comprises a blend of about 75% by weight of a high resilience ionomer and about 25% by weight of a very low modulus ionomer, wherein the high resilience ionomer is a copolymer of approximately 81% of an olefin with about 19% of an alpha, beta ethylenically unsaturated caboxylic acid, where acid groups of the high resilience ionomer are neutralized with a sodium ion, and wherein the very low modulus ionomer is a terpolymer of 67-70% by weight of ethylene, 20-21% by weight of n-butyl acrylate, and 12% by weight of methacrylic acid, where acid groups of the very low modulus ionomer are neutralized by a zinc ion.
7. The golf ball of claim 1 wherein the cover has a thickness of in the range of about 0.052 inches to about 0.063 inches.
8. The golf ball of claim 1 wherein the outer surface comprises a plurality of dimples arranged on the outer surface to form a dimple pattern, the plurality of dimples including
 - a first set of dimples, with each dimple in the first set having a single radius cross section;
 - a second set of dimples, with each dimple in the second set having a dual radius cross section; and
 - a third set of dimples, with each dimple in the third set having a single radius cross section.

9. The golf ball of claim 8 wherein

the dimples in the first set of dimples have a diameter of 0.156 inches and a major radius of 0.4148 inches;

the dimples in the second set of dimples have a diameter of 0.145 inches, a major radius of 0.7874 inches, and a minor radius of 0.1181 inches; and

the dimples in the third set of dimples have a diameter of 0.140 inches and a major radius of 0.3535 inches.

10. The golf ball of claim 8 wherein

the dimples in the first set of dimples have a diameter in the range of 0.150 inches to 0.160 inches, and a major radius in the range of 0.34 inches to 0.80 inches;

the dimples in the second set of dimples have a diameter in the range of 0.140 inches to 0.150 inches, a major radius in the range of 0.41 inches to 0.80 inches; and a minor radius in the range of 0.10 inches to 0.12 inches; and

the dimples in the third set of dimples have a diameter in the range of 0.135 inches to 0.145 inches, and a major radius in the range of 0.34 inches to 0.80 inches

11. The golf ball of claim 8 wherein the outer surface is divided into a plurality of polygonal configurations which include pentagons, squares and triangles, wherein a first pattern of dimples is associated with each pentagon, a second pattern of dimples is associated with each square, and a third pattern of dimples is associated with each triangle.

12. The golf ball of claim 8 wherein the dimples in the first set of dimples have a different size than the dimples in the third set of dimples.
- 13 The golf ball of claim 8 wherein the outer surface is divided into a polyhedron defined as a rhombicosadodecahedron and dimples are arranged using that pattern.
14. The golf ball of claim 8 wherein the total number of dimples is at least 402.
15. A method of preparing a golf ball comprising:
- a) producing a solid rubber center; wherein the center has a compression in the range of about 60 PGA to 80 PGA and a weight in the range of about 27.5 grams to 28.5 grams,
 - b) wrapping the solid rubber center with thread windings in an open pattern to form the golf ball core layer,
 - c) winding the thread windings around the solid rubber center with a thread tension from about 900 grams to 1100 grams to a thread winding thickness of between 0.20 inches and 0.26 inches, wherein the thread windings have an unstressed thread dimension of about 1/16th of an inch width by about 0.020 inches to 0.028 inches height, and a 500% modulus between 220 to 280 p.s.i.;
 - d) providing a ionomer mixture for a golf ball cover; wherein the ionomer mixture comprises a blend of 75% by weight of a high resilience ionomer and about 25% by weight of a very low modulus ionomer, wherein the

high resilience ionomer is a copolymer of approximately 81% of an olefin with about 19% of an alpha, beta ethylenically unsaturated carboxylic acid, where acid groups of the high resilience ionomer are neutralized with a sodium ion, and wherein the very low modulus ionomer is a terpolymer of 67-70% by weight of ethylene, 20-21% by weight of n-butyl acrylate, and 12% by weight of methacrylic acid, where acid groups of the very low modulus ionomer are neutralized by a zinc ion.

- e) compression molding the ionomer mixture to the golf ball core to produce the golf ball cover; wherein the cover has a Shore D hardness in the range of about 63 Shore D to about 69 Shore D;
- f) applying a dimple configuration to the outer surface of the golf ball cover, wherein the outer surface is divided into a polyhedron defined as a rhombicosadodecahedron and dimples are arranged using that pattern; and
- g) further processing the golf ball by steps such as pressure blasting, vibratory finishing, stamping of the logo, applying a primer, and applying a top coat.

15. The method of claim 15 wherein in the production of the center the center has a diameter in the range of about 1.340 inches to about 1.370 inches.

16. The method of claim 15 wherein in the formation of the core the core has a weight in the range of about 34.5 grams to about 35.5 grams.

17. The method of claim 15 wherein in the formation of the core the core has a compression in the range of about 60 PGA to about 80 PGA.
18. The method of claim 15 wherein in the formation of the core the core has a diameter in the range of about 1.555 inches to about 1.575 inches.
19. The method of claim 15 wherein in the production of the cover the cover has a thickness of in the range of about 0.052 inches to about 0.063 inches.
20. The method of claim 15 wherein in the application of the dimple configuration the total number of dimples is at least 402.
21. The method of claim 15 wherein in the application of the dimple configuration the outer surface comprises a plurality of dimples arranged on the outer surface to form a dimple pattern, the plurality of dimples including
- a first set of dimples, with each dimple in the first set having a single radius cross section;
 - a second set of dimples, with each dimple in the second set having a dual radius cross section; and
 - a third set of dimples, with each dimple in the third set having a single radius cross section.
22. The method of claim 21 wherein in the application of the dimple configuration

the dimples in the first set of dimples have a diameter of 0.156 inches and a major radius of 0.4148 inches;

the dimples in the second set of dimples have a diameter of 0.145 inches, a major radius of 0.7874 inches, and a minor radius of 0.1181 inches; and

the dimples in the third set of dimples have a diameter of 0.140 inches and a major radius of 0.3535 inches.

23. The method of claim 21 wherein in the application of the dimple configuration

the dimples in the first set of dimples have a diameter in the range of 0.150 inches to 0.160 inches, and a major radius in the range of 0.34 inches to 0.80 inches;

the dimples in the second set of dimples have a diameter in the range of 0.140 inches to 0.150 inches, a major radius in the range of 0.41 inches to 0.80 inches; and a minor radius in the range of 0.10 inches to 0.12 inches; and

the dimples in the third set of dimples have a diameter in the range of 0.135 inches to 0.145 inches, and a major radius in the range of 0.34 inches to 0.80 inches.

24 The method of claim 21 wherein in the application of the dimple configuration

the outer surface is divided into a plurality of polygonal configurations which include pentagons, squares and triangles, wherein a first pattern of dimples is associated with each pentagon, a second pattern of dimples is associated with each square, and a third pattern of dimples is associated with each triangle.

25. The golf ball of claim 21 wherein in the application of the dimple configuration the dimples in the first set of dimples have a different size than the dimples in the third set of dimples.

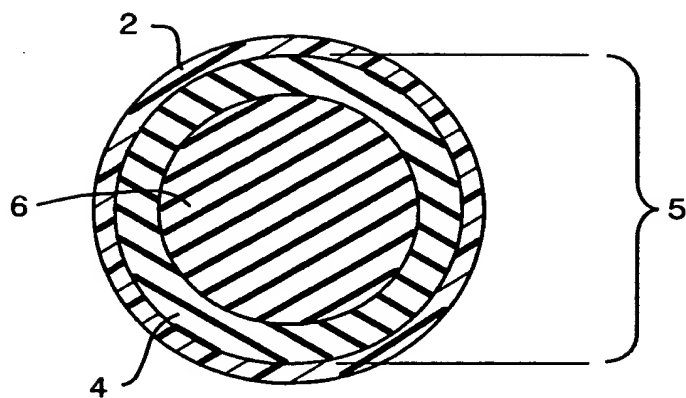


FIG. 1

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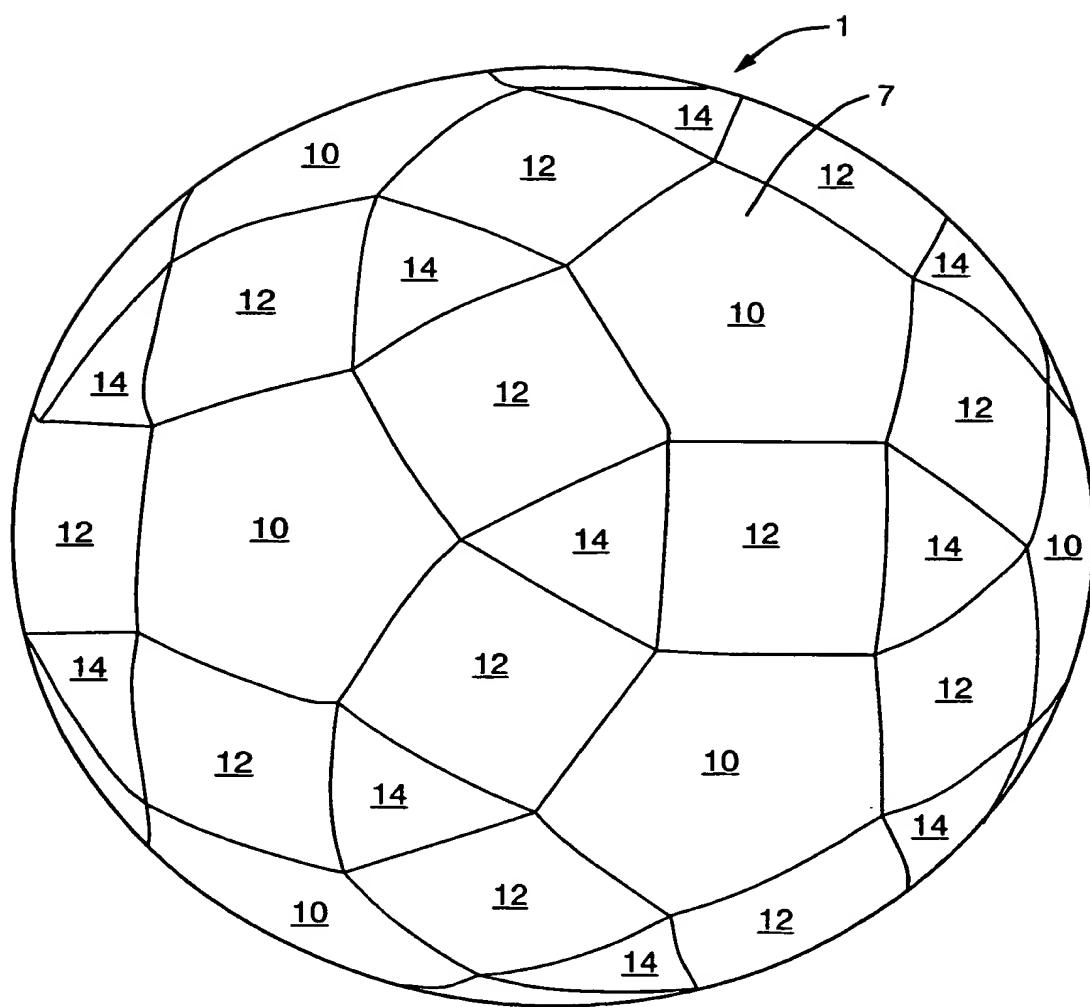


FIG. 2

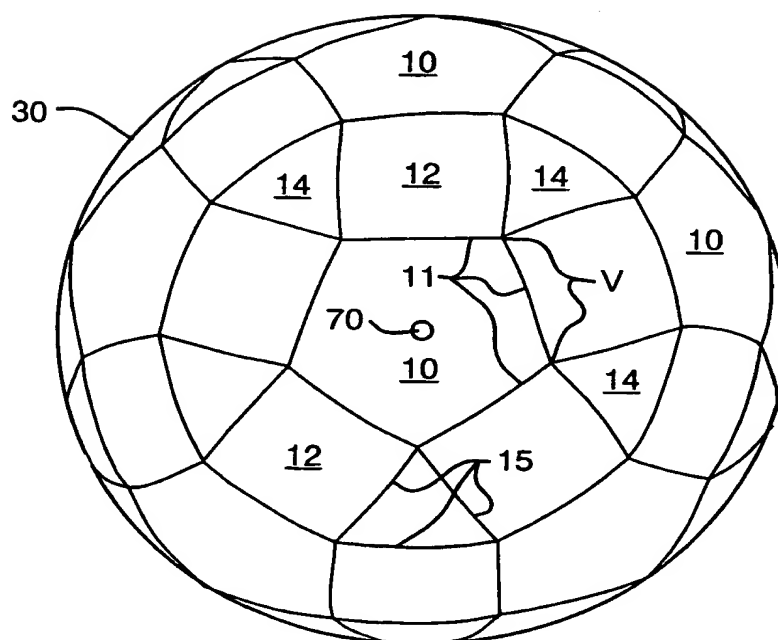


FIG. 3

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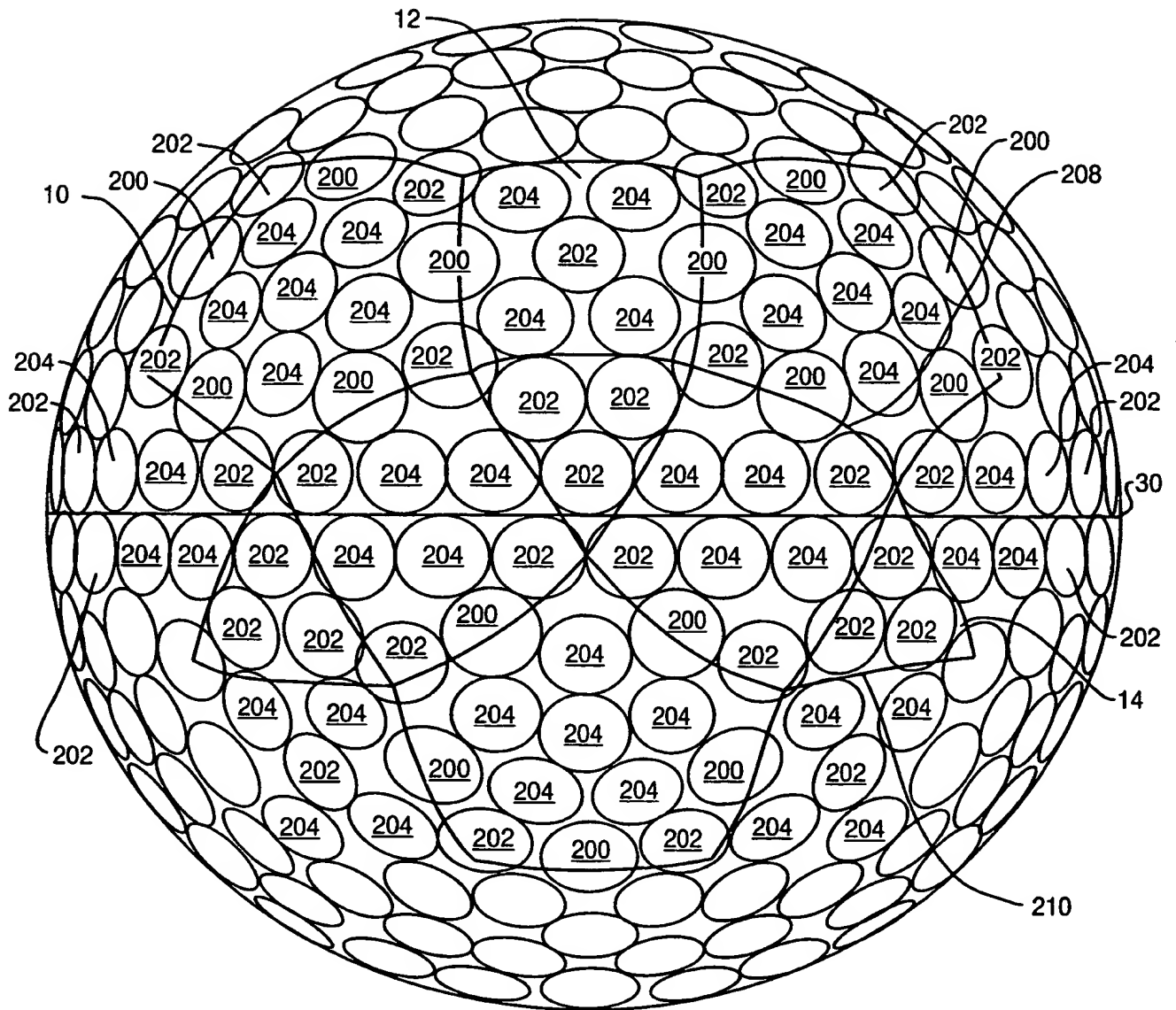


FIG. 4

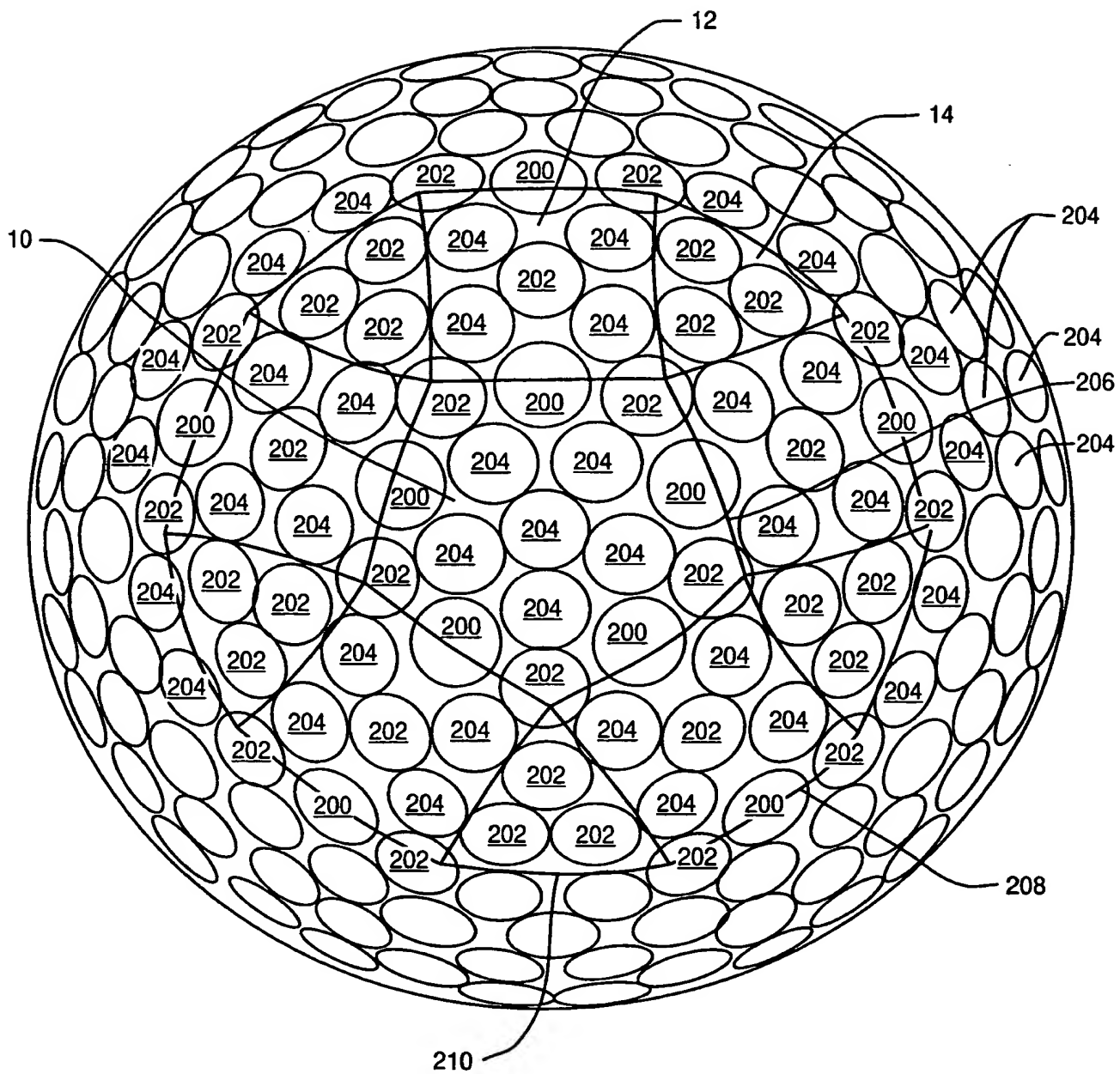


FIG. 5

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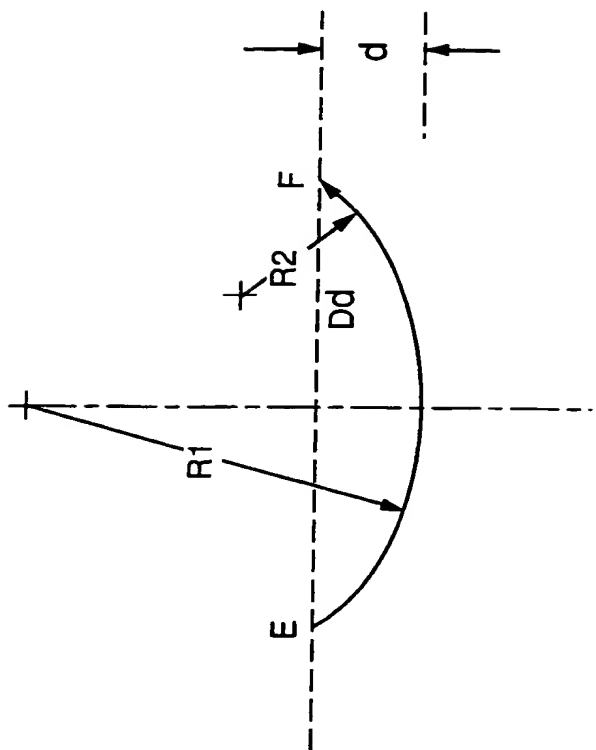


FIG. 7

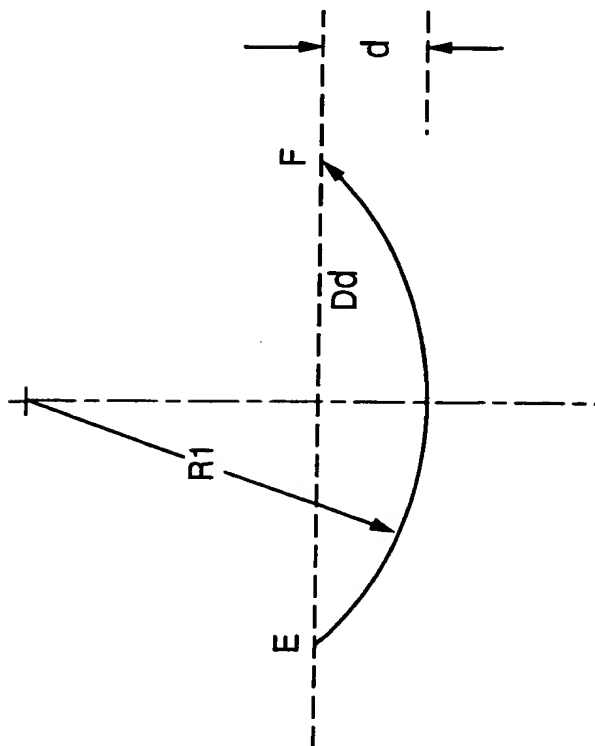


FIG. 6

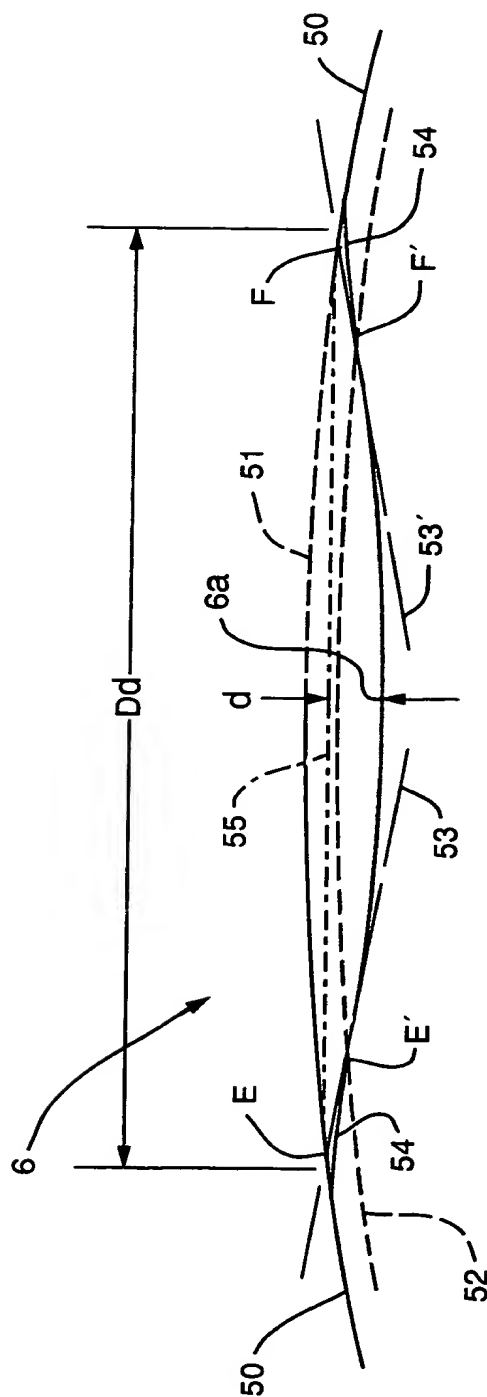


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/11944

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A 63 B 37/12

US CL : 473/383

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 473/383, 378, 379, 380, 381, 382, 384.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,823,888 A (<i>MARUKO et al.</i>) 20 October 1998, See abstract.	1-14
Y	US 5,441,276 A (<i>LIM</i>) 15 August 1995, See figure 3a.	1-14
Y	US 5,064,199 A (<i>MORELL</i>) 12 November 1991, See abstract.	1-14
Y	US 5,092,604 A (<i>OKA</i>) 03 March 1992, see the entire document.	1-14
A	US 5,078,402 A (<i>OKA</i>) 07 January 1992.	
A	US 5,308,076 A (<i>SUN</i>) 03 May 1994.	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

22 JUNE 2000

Date of mailing of the international search report

14 JUL 2000

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